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08/18/02 14:53; JmFax #448; Page 0/12

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File: DWPI

Dec 10, 1984

DERWENT-ACC-NO: 1985-023029  
DERWENT-WEEK: 198504  
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TITLE: Diamond sintered body useful as cutting tool or drawing die - comprises super-hard alloy substrate and sintered layer consisting of diamond particles and surface-treated iron gp. metal binder

PATENT-ASSIGNEE: SUMITOMO ELECTRIC IND CO (SUMS)

PRIORITY-DATA: 1983JP-0091691 (May 24, 1983)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
JP 59219500 A	December 10, 1984		004	

APPLICATION-DATA:

PUB-NO	APPL-DATE	APPL-NO	DESCRIPTOR
JP59219500A	May 24, 1983	1983JP-0091691	

INT-CL (IPC): B22F 3/24; C25P 5/00

ABSTRACTED-PUB-NO: JP59219500A  
BASIC-ABSTRACT:

The improvement is that the surface portion of the iron gp. metal binder is dissolved and removed by treating with an acid soln. or by electrolysis.

The substrate e.g. consists of WC - 10%Co alloy. The diamond sintered layer normally has a thickness of 0.3-0.5mm, and the thickness of the surface portion to be removed is pref. at least 0.2mm.

USE/ADVANTAGE - The diamond sintered body shows good heat resistance and durability, and is suitable as cutting tools or drawing dies etc..

ABSTRACTED-PUB-NO: JP59219500A  
EQUIVALENT-ABSTRACTS:

CHOSEN-DRAWING: Dwg.0/0

DERWENT-CLASS: L02 M22 P53  
CPI-CODES: L02-P05; M22-M03G;

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Number of Inventors: 2  
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(54) Title of the Invention: DIAMOND SINTERING AND PROCESSING METHOD  
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(21) Application No.: S58-91691  
 (22) Application Filed: May 24, 1983  
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# Specification

## 1. Title of the Invention: DIAMOND SINTERING AND PROCESSING METHOD

### 2. Patent Claims

- (1) A sintered diamond layer made from diamond and a ferrous metal binder phase is joined to a base material made from an ultra-hard alloy during high-pressure sintering, forming a hybrid sintered object. The majority of a ferrous metal binder phase that is already contained in the surface layer section at least 0.2 mm from the surface layer of the diamond sintered layer is removed electrolytically.
- (2) A method of processing sintered diamond objects with the following characteristics. A composite sintered diamond object is made by joining an ultra-hard alloy base material with a layer of a sintered diamond object that is made from a ferrous metal binder phase and diamond that is sintered under high pressure. Only the sintered diamond layer is immersed in acid or an electrolytic solution until the ferrous metals in the surface layer of the sintered diamond object have been dissolved.

### 3. Detailed Description of the Invention

#### (a) Technical Fields

This invention pertains to sintered diamonds, which are produced under ultra-high pressure and high temperatures and are used in machine tools and tools for digging and drilling through rock. In particular, it pertains to the marked improvement of such tools.

#### Prior Art and Problems

Diamond sintered objects produced by sintering diamond powder with metal as a binder under stable, ultra-high pressure and high temperature are among the most rigid of all diamond tool materials. Like monocrystalline diamond, there is no low-stress damage brought on by cleavage, so they are used in a wide variety of tools including machine tools, wire-drawing dies,

dressers and rock cutting tools. Depending upon the use, these sintered diamond objects have all sorts of structures and shapes, but generally, there is a layer of sintered diamond like the one shown in Figure 1, which is bonded to a highly rigid base material such as an ultra-hard alloy for use in machine tools, dressers and rock cutting tools. Sintered objects with this sort of structure are known and have been described in JSP S46-005204, for example, where a sintered diamond is joined directly to a WC base, ultra-hard alloy material or JSP S54-045313 and JSP S56-00506, where the sintered diamond layer is joined to an ultra-hard alloy material through an intermediate binder layer. Currently, sintered diamond layers of this sort now often use a ferrous metal such as Co as a binder for the diamond granules. When synthesizing diamond from graphite, ferrous metal is used as a solvent and during sintering under ultra-high pressure, part of the diamond powder melts and, it is believed that this has the effect of causing the diamond granules to sinter into each other. These ferrous metals may be mixed with the diamond powder before sintering or, as in JSP S46-005204, the base material WC-Co lubricating binder may be placed in the diamond powder during sintering. Sintered diamond of this sort has superior wear resistance and exhibits superior performance in uses where monocrystalline diamond has traditionally been used. At the same time, however, there are significant limitations on the heat resistance. In the atmosphere, a diamond's surface turns to graphite at temperatures of 900° C or more. In a vacuum or in inert gas, graphite does not form easily even around 1400° C. In the conventional sintered diamond described above, inferior tool performance is seen at around 750° C. Naturally this means that when the tip of the machine tool or cutting tool reaches a high temperature during use, a decline in performance will be seen. It is believed that the reason that conventional sintered diamond degrades at a level of temperature than simple diamond is that there is a significant difference between the thermal expansion coefficients of the ferrous metal binder and the diamond. During heating, the amount of thermal stress in the sintered object increases and the structure breaks down. Additionally, ferrous metals have the effect of promoting the conversion of diamond into graphite. As a means of improving the heat resistance of sintered diamond, sintered objects have been created that are not bound to ultra-hard alloy base materials, which are then immersed in aqua regia or similar substance and heat treated. This dissolves the metal binder phase in the sintered object (JSP S53 - 114589). This is said to allow the sintered diamond to withstand temperatures of up to 1200° C. However, the metal binder phase escapes, leaving cavities in the sintered material, which degrades the strength of the sintered material. The result is a material which lacks sufficient hardness as a tool. With this method, there are also considerable binding limitations, which makes a strong bond between the sintered diamond and the tool difficult.

(b)

The purpose of this invention is to provide a new sintered diamond material that resolves the deficiencies of this sort of conventional sintered material. For instance, when using sintered diamond as a cutting tool, the part that becomes hottest is the tip of the tool that comes into contact with the material being worked. The temperature slope acid of this section is considerable and as one moves away from the point of contact of the material being worked, the temperature drops quickly. Therefore, improving the heat resistance of just the surface portion of a disk-shaped sintered object like the one in Figure 2, would offer a significant improvement in the performance of such a tool. This invention is based on this point. It is a composite sintered diamond layer, from which the binder phase has been removed from the surface layer. In this composite, the sintered diamond layer is joined to the ultra-hard alloy base material during ultra-

high pressure sintering of diamond and a ferrous metal binder phase as shown in Figure 2. The thermal resistance of tools made using this process is improved considerably. Additionally, there is binder phase inside the sintered diamond, so there is less loss of strength in the sintered object overall. Again, because there are no interior cavities, the thermal conductivity does not decline, which is effective in dispersing the heat that is generated at the tip of the tool. In the sintered objects of this invention, the thickness of the sintered diamond layer is normally 0.3 ~ 5 mm and this is joined to the ultra-hard alloy base material during ultra-high pressure sintering. The majority of the ferrous metal binder phase is removed from an area that is at least 0.2 mm of the surface layer of the sintered diamond layer. In the production of the sintered objects of this invention, methods described in JSP S46-005204, S54-045313 and S56-055506 which are mentioned above, could be used. Using these methods, composite sintered objects that join a diamond layer that is 0.3 ~ 5 mm to an ultra-hard alloy base can be obtained. In order to remove the ferrous metal binder phase from the sintered diamond surface layers of these sintered composites, electrolytic removal may be employed by placing a spongy material containing an aqueous hydrochloric acid solution on the surface of the sintered object and applying a DC voltage. Using this sort of method, the binder phase can be removed from just the surface layer of the sintered diamond object without having the acid cause any damage to the ultra-hard alloy that serves as the base material.

#### (c) Effect of the Invention

This invention makes it possible to improve significantly, the performance limit of insufficient heat resistance found in conventional composite sintered diamond used in tools, without damaging its strength. The following are the embodiments.

#### Embodiment 1

We made a sintered composite having the structure shown in Figure 1 by joining a sintered diamond object that was 26 mm in diameter and 1 mm thick with a base material that was made of WC-10% Co that was 2.5 mm thick. The sintered diamond object contained diamond particles having a granularity averaging 5  $\mu$  that was 90% by volume and the remainder consisted of a Co binder phase. The surface of the sintered diamond layer in this sintered object was placed in contact with a plastic sponge containing hydrochloric acid water. Ten volts DC was applied between the ultra-hard alloy base and an electrode that had been placed below the sponge and left for 2 hours. Then the power was shut off and the sintered object was cut into many triangular pieces using electrical discharge machining. The cut surfaces were polished and examined, revealing that nearly all of the metal Co binder phase in an area 0.5 mm from the surface of the sintered diamond object had been removed electrolytically. We then ran alumina ceramic cutting tests by applying wax to another ultra-hard alloy metal base plate. For comparison, the same sort of unprocessed, composite sintered object was created using a tool of the same shape. The cutting tests were run under the following conditions: a 0.15 mm cut was made at a cutting speed of 60 m/minute and a feed of 0.02 mm/revolution while applying an aqueous cutting agent. With the sintered object of this invention, we were able to cut for 50 minutes until the relief wear land of the tool reached 0.4 mm, while the same relief wear land was attained after 10 minutes with the comparison sintered object.

#### Embodiment 2

In the same manner as Embodiment 1, we produced a core bit that was 46 mm in diameter using 4 of the sintered objects of this invention that were 8 mm in diameter with a 2.5 mm diamond sintered ultra-hard alloy base material. For the purpose of comparison, an object that was 8 mm in diameter and 2 mm thick made just from sintered diamond was heat-treated in aqua regia, resulting in a sintered object from which most of the metal Co binder phase had been removed. A core bit in the same shape was also produced. We ran uniaxial compressive strength tests (cutting 1.650 kg/cm<sup>2</sup> andesite) on both bits. At a speed of 200 rpm with identical pressure applied to the bits, the bit using the sintered material of this invention could cut 20 m at a cutting speed of 10 cm per minute. Conversely, the bits using the comparison sintered material all broke during the initial cutting period.

#### 4. Simple Description of Drawings

Figure 1 is an oblique view of a conventional diamond composite sintered object. 1 is the diamond sintered portion and 2 is the ultra-hard alloy base material. Figure 2 is a cross section of the sintered object of this invention. 1 and 2 are the same as in Figure 1. 1' is the area where most of the ferrous metal binder phase was removed from the diamond sintered material.

Representative and Patent Attorney: Tetsuji Jodal

/official stamp/

Figure 1

Figure 2

Procedural Corrections

June 27<sup>th</sup>, 1983

To: Kazuo WAKASUGI, Patent Office Official

1. Matter Disclosed

1983, Patent Application No. 91691

2. Title of the Invention

Sintered Diamond Object and Its Processing Method

3. Party Making the Correction

Relationship to this Matter: Patent Applicant

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5. Date Correction Ordered

Voluntary Correction

Patent Office Stamp

June 29<sup>th</sup>, 1983

Applications, Section 2  
Ikeda

6. Object of Correction

Detailed Description of Invention in the Detailed Description

7. Description of Corrections

(1) We will make the following corrections to the detailed description of the invention.

(a) Page 2 line 4 of the document described above, "Conventional Technology and Problems" is to be corrected to read "(b) Conventional Technology and Problems."

(b) Page 4, line 8 of the document described above, "level of temperature" is to be corrected to read "low temperature."

(c) Page 5, line 5 of the document described above, "(b) Configuration of the Invention" is to be corrected to read "(c) Configuration of the Invention."

(d) Page 5, line 11 of the document described above, "slope acid" is to be corrected to read "slope."

(e) Page 7, line 3 of the document described above, "(c) Effect of the Invention" is to be corrected to read "(d) Effect of the Invention."

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713 934 8809;

06/18/02 14:58; John #448; Page 12/12

- (f) Page 8, last line of the document described above, "1.65" is to be corrected to read "1.65."
- (g) Page 9, line 3 of the document described above, "moat advance" is to be corrected to read "cut info."
- (h) Page 9, line 4 of the document described above, "moat cut" is to be corrected to read "cut."
- (i) Page 9, line 5 of the document described above, "moat cut" is to be corrected to read "cut."